

I think this work is meaningful for monitoring and modeling carbon storage and uptake of Mediterranean tree species. Although they extracted canopy structure parameters using existing methods, evaluating the WAI of different tree species is valuable for relevant ecological and forestry research. I think this article's first and foremost improvement point is that the research goal is not clear and in-depth enough. The presentation of the results is not complete, which makes it difficult for readers to capture their needed information, such as the WAI variation trend (functions) among 5 tree species related to their height and density.

Authors think the TLS-based canopy metrics are not yet reliably calibrated and validated to the extent they are ready to replace traditional approaches for large-scale monitoring of PAI and LAI. In most studies, TLS data only depicts the tree structure at the plot- and single-tree scale. While using other remote sensing technologies cannot depict the fine structure features of the internal canopy and separating woody and foliage materials. Referring to the DHP results, authors evaluated the error of WAI and PAI analyzed by point clouds. I would like to know if the authors use the TLS data to improve the LAI evaluation accuracy. TLS can support assessing the single tree and plot-level WAI more accurately. More importantly, whether the WAI of different Mediterranean trees has similarities between the same species, as well as providing specific information (maybe list in thematic tables to show the relationship among species, tree height, density, and PAI), will make readers benefit greatly. I think the measured data of this study can support this research goal, while they are not fully presented in the current edition.

In addition, the presentation of the results is incomplete. I did not find the location, site conditions and tree species appearance of the measured plots shown in the manuscript. The segmentation results of different tree species and the statistical information on PAI and WAI of trees grown in different site conditions were also not provided. In addition, critical mathematical functions and quantitative conclusions are also lacking in the current edition.

I suggest authors reconsider whether it is necessary to study the CAI. This parameter can be easily analyzed using remote sensing images without using TLS.

Furthermore, is it applicable to use a fixed voxel size when analyzing WAI? After all, different tree species have various canopy shapes and branch structure features. Adaptive adjusting the voxel size according to the point cloud density and the branch distribution trend may be more reasonable.

Optimizing the TLS-based WAI assessment methods, summarizing the regulation of interspecific WAI variation, and using these rules to improve the LAI assessment will make this article more attractive to better support research in related fields. **The following are some detailed points.** I hope they will help improve the current edition.

- I suggest authors clarify their research goal in the initial section of the manuscript. As a reader, I am more interested in how to use TLS to analyze WAI. However, authors did not briefly introduce the WAI extraction methods in the abstract but focused on comparing point cloud extraction methods of PAI and LAI.
- They focused on the wood to total plant area ( $\alpha$ ). I wonder if it is feasible to measure the plant area because of the occlusion effect during scanning. TLS may be more suitable for analyzing WAI.
- Section 1.3 It will be more interesting to add some research topics on integrating the fine-scale WAI (or  $\alpha$ ) assessed based on TLS to correct the large-scale LAI extracted from the multi-source remote sensing images. Based on the high-quality field dataset, it should be feasible to use this research in optimizing the large-scale LAI distribution evaluation.
- In Sections 2.1 and 2.2, the location map of study plots and some images showing the scene of plots should be provided. The pictures of tree species also need to be added to show their phenotypic characteristics, which is beneficial to evaluate their drought tolerance (L323-324).
- L 191 When setting this threshold ( $> 0$  points) to identify the filled voxels, did you filter noisy points out from the tree TLS datasets? It is not easy to identify and filter all noise in TLS data. I am worried the noise would lead to a lower  $P_{\text{gap}}$  and cause inaccurate LAI and PAI.
- L203-204 Some structure features of woody and foliage materials can be analyzed based on the pointset-, height bin-, and patch-based models. Please

revise this sentence.

- L206 The principle of TLS segmentation methods needs to be briefly introduced before the voxelization step. It is beneficial to improve the readability of the manuscript.
- L216 How to analyze the WAI after voxelizing woody point clouds? Some details should be introduced, which is key to calculating  $\alpha$ .
- L225 Why explore the relationship between PAI and CAI in this study? The CAI assessment seems to deviate from the research topic, as it is not highly related to LAI and WAI but to the crown projection area, except the canopy gap area. Moreover, using images for CAI analysis is sufficient.
- L245 As shown in Figure 3, PAI estimated using the LiDAR Pulse method more strongly agreed with DHP PAI than the Intensity Image method. However, I found their correlation ( $R^2$ ) is not particularly significant.
- L248 Please carefully recheck the description of the results is correct according to Figure 3. As shown in Figure 3a, the Pulse-based method overestimates the PAI, while the intensity-based method underestimates the PAI.
- L264 You did not label Voxel-Based PAI in Figure 3. Do you mean the TLS PAI?
- L269 Maybe you did not set a suitable threshold when defining blank voxels. Merely my speculation!
- L282 and 257 You forget to mark the 1:1 dash line in these figures.
- Although authors used the published woody-and-foliage separation methods, it is necessary to display some examples of TLS separation results scanned from diverse plots grown with different species. Due to the lack of validation data, it may be challenging to evaluate the segmentation accuracy. However, presenting the separation results is still available to support visual evaluation.
- It is not easy to accurately separate the branch and leaf point clouds of trees except those of broadleaf. More importantly, I am worried about whether it is applicable to use the same voxel size to calculate the WAI of different tree species, which is crucial to the conclusion.
- L294-297 These sentences are not clear. How to assess tree-specific drought

tolerance? You would better add some description about its evaluation methods and list the metrics to evaluate the drought tolerance of different tree species in this figure and the related references.

- In section 4.1, why did you discuss the plot-scale CAI variation? The topic of this section is comparing diverse approaches to deriving PAI.
- The title of Section 4.2 is a phenomenon that you need to analyze. Sections 4.2 and 4.3 still belong to Section 4.1 to discuss the LiDAR-extracted metrics with that of DHP.
- L320 According to the field data and Figure 3, what is a very low PAI value? Providing a quantitative indicator will significantly improve the manuscript's readability than using adjective words.
- L348 The highest  $R^2$  does not show a strong correlation.
- L374 This sentence is not clear. “Although species explain some variation in  $\alpha$ , tree height and plot CAI were stronger predictors for all species....” According to the principle of these parameters, it is hard for me to agree that CAI and WAI have a strong correlation.
- L390-392 This is an interesting point. I prefer you to provide some figures and statistical information to prove your finding, especially in different plots with variable growing patterns (growing density, CAI, and WAI related to the tree species, as you mentioned in the Conclusion section). It is beneficial to deepen this study topic.
- L 398 I agree that correcting WAI can improve the LAI assessment. The TLS-extracted data can support calibrating LAI based on WAI and PAI. The WAI may be similar among single trees of the same tree species. According to your results, the WAI shows a more evident relationship to tree height and stand density. I think the assessed WAI and plot-level PAI can be used to correct regional LAI for the plot or large-scale forests that were growing with limited tree species.

**Some text errors that needed to be corrected are listed as follows:**

- Do not use an abbreviation in the title of your manuscript, as many readers in other fields do not know the meaning of TLS.

- I suggest authors unify the reference format throughout their manuscript. Different citation formats appear in the same paragraph may confuse readers.
- L135 What are FunDIV plots?
- L142 I do not understand “altitudinal gradient 840 – 1400 m.a.s.l.”.
- L167 compare –> compared
- L169 and 180 Please note the font size of the subscript in the P<sub>gap</sub>. This abbreviation can also be used in line 162.
- L176 Please add a comma to this sentence.
- L199 Where are the solid black voxels in Figure 2?
- L209 wood only point clouds?
- L210 TLSeparation classifies points as leaf or wood? This sentence is not clear.
- L219 TLS PAI and DHP PAI? (Using PAI<sub>TLS</sub> and PAI<sub>DHP</sub> instead)
- L234 Please add a comma to this sentence.
- L246-248, L264-265 You can mark these metrics in the insets of Figure 3.
- Points in Figure 3 can be denoted as different marks or colors, such as circles or crosses, red or blue, to make this chart clearer (like the style of Figure 4).
- L262 Please unify the term throughout the manuscript. I think TLS whole plot PAI means TLS PAI(PAI<sub>TLS</sub>).
- L274-276 You would better mark these metrics in the subfigures of Figure 4.
- In Figures 3 and 4, please delete the unit of PAI. The PAI, LAI and WAI are all ratio-type parameters (no need to denote unit).
- L318 TLS – DHP comparisons?
- In this article, authors used lots of open-source software to support their analysis. I suggest they list all applicable packages and download links to make readers easy to use these tools.
- Please carefully check the format of all references according to the manuscript preparation guidelines and the latest published papers in Biogeosciences. The current reference format needs to be optimized.